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ABSTRACT

This activity packet provides educators with a series of hands-on classroom and outdoor education activities for grades 9-12 that focus on geology using the Pilot Mountain State Park. The packet was designed to meet established curriculum objectives of the North Carolina Department of Public Instruction's Standard Course of Study. Three types of activities are included: (1) pre-visit classroom activities provide background and vocabulary development; (2) on-site activities conducted at the park; and (3) post-visit classroom activities to reinforce concepts, skills, and vocabulary. This learning experience exposes students to the major concepts of classes of rocks, physical properties of rocks and minerals, formation of rocks and minerals, weathering and erosion, geologic processes, rock and mineral identification, rock cycles, and geologic time. The packet contains an introduction to the geologic history of Pilot Mountain; an activity summary; pre-visit, on-site, and post-visit activity objectives and instructions; a glossary; a list of 14 references; a scheduling worksheet and program evaluation form; and instructions on conducting a daily meal production plan. (LZ)

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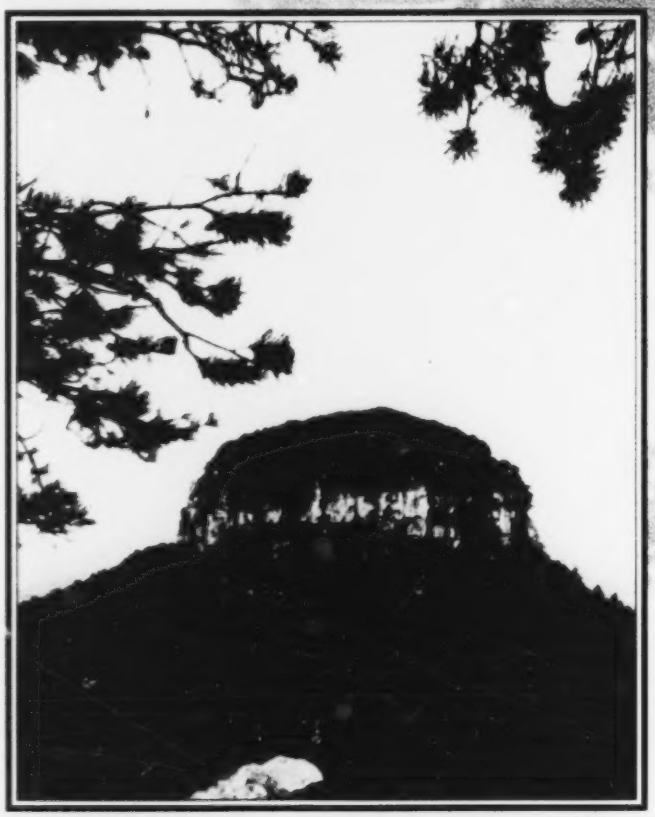

GEOLOGY

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Pilot Mountain State Park

An Environmental Education Learning Experience

Designed for Grades 9-12

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JOMEOKEE

GEOLOGY

Pilot Mountain State Park

An Environmental Education Learning Experience

Designed for Grades 9-12

"The Earth is not static.
The forces that shape its surface
are at work all the time,
slowly heaving up the mountains
and just as slowly wearing them away."

- The Practical Geologist.
Dixon & Bernor, ed.

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CP&L

This Environmental Education Learning Experience
was developed by

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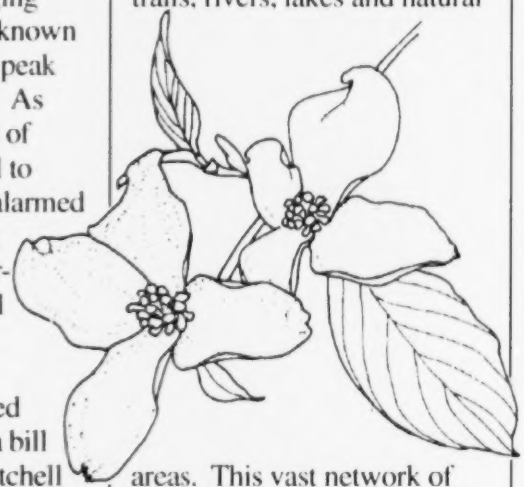
Introduction to the North Carolina State Parks System

Preserving and protecting North Carolina's natural resources is actually a relatively new idea. The seeds of the conservation movement were planted early in the 20th century when citizens were alerted to the devastation of Mount Mitchell. Logging was destroying a well-known landmark - the highest peak east of the Mississippi. As the magnificent forests of this mile-high peak fell to the lumbermen's axe, alarmed citizens began to voice their objections. Governor Locke Craig joined them in their efforts to save Mount Mitchell. Together they convinced the legislature to pass a bill establishing Mount Mitchell as the first state park of North Carolina. That was in 1915.

The North Carolina State Parks System has now been established for more than three quarters of a century. What started out as one small plot of public land has grown into 59 properties across the state, including parks, recreation areas, trails, rivers, lakes and natural areas. This vast network of land boasts some of the most beautiful scenery in the world and offers endless recreation opportunities. But our state parks system offers much more than scenery and recreation. Our lands and waters contain unique and valuable archaeological, geological and biological resources that are important parts of our natural heritage.



As one of North Carolina's principal conservation agencies, the Division of Parks and Recreation is responsible for the more than 125,000 acres that make up our state parks system. The Division manages these resources for the safe enjoyment of the public and protects and preserves them as a part of the heritage we will pass on to generations to come.

An important component of our stewardship of these lands is education. Through our interpretation and environmental education services, the Division of Parks and Recreation strives to offer enlightening programs which lead to an understanding and appreciation of our natural resources. The goal of our environmental education program is to generate an awareness in all individuals which cultivates responsible stewardship of the Earth.

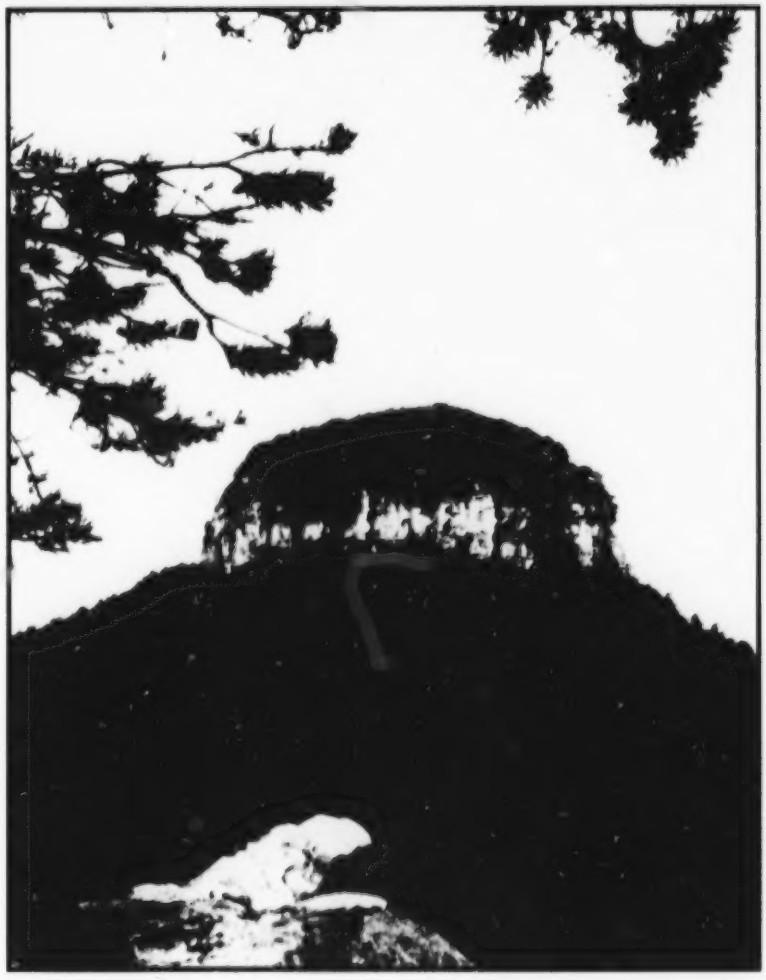
For more information contact:

N.C. Division of Parks and Recreation
P.O. Box 27687
Raleigh, NC 27611-7687
919/ 733-4181

Introduction to Pilot Mountain State Park

Pilot Mountain is one of the most visible and recognizable geologic formations in the piedmont of North Carolina. Its prominent pinnacles, towering above the surrounding landscape, have been a local landmark since long before the early European settlers inhabited the area. The Saura tribe of Native Americans used the pinnacles as a navigation aid in the area. In fact, *Pilot* is a translation of the Native American name for the formation, *Jomeokee*.

Pilot Mountain became North Carolina's fourteenth state park in 1968 due to the efforts of the Pilot Mountain Preservation and Park Committee. This group of local citizens wanted to ensure that this geologic landmark would be protected for future generations of North Carolinians. Today the park totals 3,703 acres. In addition to the Pilot Mountain section, the park includes a Yadkin River section and a 5-mile long corridor connecting the two sections. Students of geology can observe evidence of a wide range of geologic processes within the three sections of the park.



Scheduling a Trip:

1. Please contact the park at least two weeks in advance to make a reservation.

2. Complete the Scheduling Worksheet located on page 8.1, and return it to the park as soon as possible.

3. Research activity permits may be required for sampling activities. If your group plans to collect any plant, animal or mineral within the park, please contact the park office at least 30 days in advance to obtain a permit application.

Before the Trip:

1. Complete the pre-visit activity in the Environmental Education Learning Experience.

2. The group leader should visit the park without the participants prior to the group trip. This will enable you to become familiar with the facilities and park staff, and to identify any potential problems.

3. The group leader should discuss park rules and behavior expectations with adult leaders and participants. Safety should be stressed.

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4. Everyone should wear a name tag. Please color-code tags (for groups) and establish a buddy system.

5. Activities that take place outdoors may expose participants to insects and seasonal weather conditions. Be prepared by dressing accordingly and wearing sunscreen or insect repellent, if necessary. Comfortable walking shoes should also be worn.

6. *The group leader is responsible for obtaining a parental permission form from each participant, including a list of any health considerations and medical needs.* An example of this form is on page 8.2.

7. *If you will be late or need to cancel your trip, please notify the park as far ahead as possible.*

While at the Park:

Please obey the following rules:

1. To help you get the most out of the experience and increase your chance of observing wildlife, be as quiet as possible while in the park.

2. On hikes, walk behind the leader at all times. Running is not permitted.

3. All plants and animals within the park are protected. Breaking plants and harming animals are prohibited in all state parks. This allows future visitors the same opportunity to enjoy our natural resources.

4. Picnic in designated picnic areas only. Help keep the park clean and natural; do not litter.

5. *In case of accident or emergency, contact park staff immediately.*

Following the Trip:

1. Complete the post-visit activity in the Environmental Education Learning Experience packet.

2. Build upon the field experience and encourage participants to seek answers to questions and problems encountered at the park.

3. Relate the experience to classroom activities and curriculum through reports, projects, demonstrations, displays and presentations.

4. Give tests or evaluations, if appropriate, to determine if students have gained the desired information from the experience.

5. File a written evaluation of the experience with the park. Evaluation forms are available in the activity packet on page 8.3.

Park Information:

Pilot Mountain State Park
Rt. 3, Box 21
Pinnacle, NC 27043
Tel: (910) 325-2355
Fax: (910) 325-2751

Office Hours:

Year-round 8:00 a.m. - 5:00 p.m.
Monday - Friday

Hours of Operation:

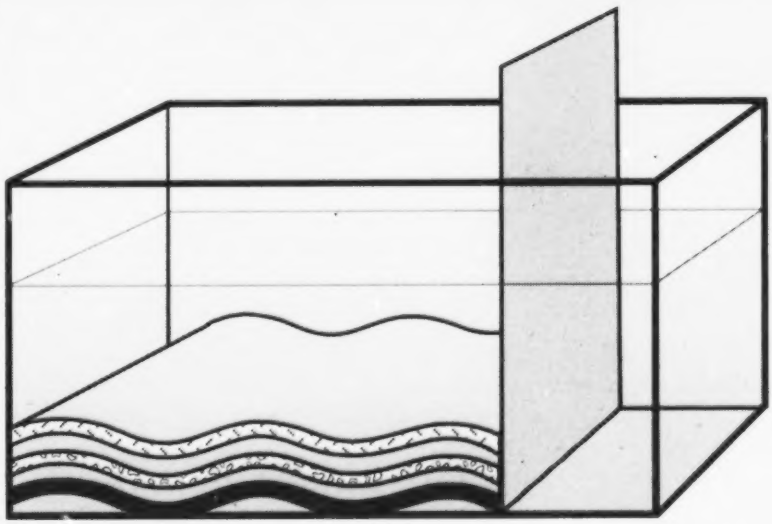
Nov - Feb	8:00 a.m. - 6:00 p.m.
Mar, Oct	8:00 a.m. - 7:00 p.m.
Apr, May, Sep	8:00 a.m. - 8:00 p.m.
Jun - Aug	8:00 a.m. - 9:00 p.m.

Introduction to the Activity Packet for Pilot Mountain State Park

The Environmental Education Learning Experience, *Jomeokee Geology*, was developed to provide environmental education through a series of hands-on activities for the classroom and the outdoor setting of Pilot Mountain State Park. This activity packet, designed for grades 9 - 12, meets established curriculum objectives of the North Carolina Department of Public Instruction's Standard Course of Study. Three types of activities are included:

1) pre-visit activity
2) on-site activity
3) post-visit activity

The on-site activity will be conducted at the park, while pre-visit and post-visit activities are designed for the classroom. Pre-visit activities should be introduced prior to the park visit so that students will have the necessary background and vocabulary for the on-site activities. We encourage you to use the post-visit activities to reinforce concepts, skills and vocabulary learned in the pre-visit and on-site activities. These activities may be performed independently; however, they have been designed to be done in a series to build upon the students' newly gained knowledge and experiences.



The Environmental Education Learning Experience, *Jomeokee Geology*, will expose the student to the following major concepts:

- **Classes of rocks**
- **Physical properties of rocks and minerals**
- **Formation of rocks and minerals**
- **Weathering and erosion**
- **Geologic process**
- **Rock and mineral identification**
- **Rock cycle**
- **Geologic time**

The first occurrence of vocabulary words used in these activities is indicated in **bold type**. Their definitions are listed in the back of the activity packet. A list of the reference materials used in developing the activities follows the vocabulary list.

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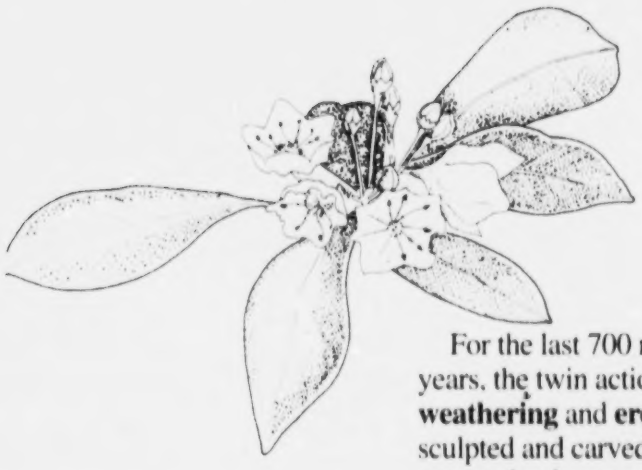
Note:
The on-site activity will require hiking which could expose the students to hot or cold conditions, ticks and insects. Accessibility to some areas may be difficult for persons with disabilities. When conducting the on-site activity, please remember that collecting specimens of any kind in the park is prohibited.

Introduction to the Geologic History of Pilot Mountain

By examining the **rocks**, **minerals** and geologic formations found in Pilot Mountain State Park, geologists have been able to recreate the story of hundreds of millions of years of its past. One billion years ago, this area was a shallow sea. For hundreds of millions of years, layer upon layer of **sediment** accumulated on the sea floor. The pressure of the overlying layers of sediment caused the formation of **sedimentary rocks**, such as sandstone. During this period, there was also some volcanic activity in the area. Approximately 700 million years ago, **magma** came up through cracks in the layers of sediments and eventually cooled to produce granite, an **igneous rock**. Igneous rocks are formed from the cooling of **lava** or magma in volcanic activities. Lava is magma that reaches the surface of the Earth. The type of rock formed depends on the rate of cooling and the mineral content.

Following the period of sediment deposition and volcanic activity, the region experienced a long period of rather violent geologic activity. The shifting of the Earth's tectonic plates applied immense compression on the existing rocks, crushing and shearing them, causing a series of folds in the Earth. This series of folds is known as an **anticlinorium**. Even though the rocks were compressed at low temperatures, the internal temperature of the rocks increased. The combination of pressure and heat during the formation of the anticlinorium changed, or metamorphosed, the sedimentary and igneous rocks into **metamorphic rocks**, such as **quartzite** (metamorphosed sandstone). Today, there are very few igneous and sedimentary rocks found in the park.



For the last 700 million years, the twin actions of **weathering** and **erosion** have sculpted and carved out the present landscape. Water, in the form of snow, rain and ice wore down and removed the less resistant rocks, such as gneiss and schist and carried them, via streams and rivers, to other areas of the piedmont and also into the Coastal Plain. Quartzite, the rock formed from metamorphosed sandstone, is much more resistant to weathering than the other types of rocks in the area. It acted as a cap over the underlying rocks, protecting them as the surrounding landscape was worn away. The resulting pinnacle formation is known as a **monadnock**. Pilot Mountain is a spectacular example of this phenomenon; many monadnocks are simply ridges or rocky hills.

Today, you can witness one billion years of history at Pilot Mountain State Park. In addition, you can see geologic history being made in the sediment deposition in and along the Yadkin River. The sand, silt and clay of today could be the sedimentary rocks of the Earth in several hundred million years, or even the metamorphic rocks of 1,000,000,000 A.D.!

Activity Summary

The following outline provides a brief summary of each activity, the major concepts introduced and the objectives met by completion of the activity.

I. Pre-Visit Activity

The pre-visit activity will introduce the students to the concepts of rock classes and how each class is formed.

#1 How Did it Form? (page 3.1.1)

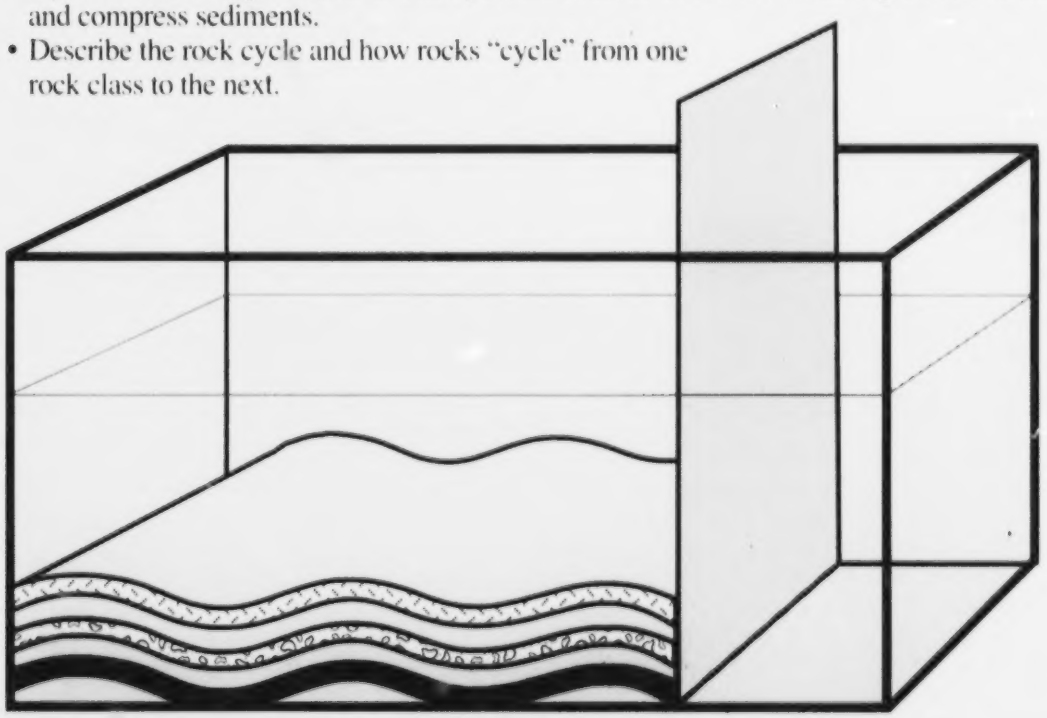
The methods of forming sedimentary, igneous and metamorphic rocks will be explored through a variety of activities, including layering sediments in an aquarium, cooking and metamorphosing crayon fragments.

Major concepts:

- Formation of rocks
- Sedimentary rock
- Igneous rock
- Metamorphic rock
- Rock cycle

Objectives:

- Describe how sedimentary rock is formed and name two common sedimentary rocks.
- Describe how igneous rock is formed and name two common igneous rocks.
- Describe how metamorphic rock is formed and name two common metamorphic rocks.
- Describe what happens to rock when powerful forces within the Earth begin to shift, move and compress sediments.
- Describe the rock cycle and how rocks "cycle" from one rock class to the next.



II. On-Site Activity

The on-site activity will give the students an opportunity to view various geological formations and types of rock found within Pilot Mountain State Park.

#1 Rock Around the Knob (page 4.1.1)

The instructor will conduct a hike along the Jomeokee Trail, stopping at designated areas to observe and discuss various geologic factors relating to the formation of Pilot Mountain.

Major Concepts:

- Rock formation
- Rock properties
- Weathering and erosion
- Topography and mapping
- Landforms

Objectives:

- Hypothesize the geologic history of Pilot Mountain State Park by learning about specific landforms and rock types.
- Identify one type of rock formation that indicates tectonic plate activity.
- Observe and list seven examples of weathering.
- Explain the difference between chemical and mechanical weathering.
- Observe and explain two geologic formations that indicate a past aquatic environment.
- Identify seven rocks and minerals that are common to Pilot Mountain.

III. Post-Visit Activity

The post-visit activity will reinforce the vocabulary and concepts learned in the pre-visit and on-site activities.

#1 Geo-Crossword (page 5.1.1)

In completing this challenging crossword puzzle, students will utilize the new vocabulary they learned in the previous activities.

Major concepts:

- Formation of rocks and minerals
- Classes of rocks and minerals
- Geologic processes
- Rock formations

Objectives:

- Name the three rock types and the processes by which they change from one to another.
- Know the difference between weathering and erosion, and the major agents causing each.
- Name three types of weathering.
- Name four geologic formations found at Pilot Mountain State Park.

Pre-Visit Activity #1 — How Did it Form?

Curriculum Objectives:
All Grades:
- Earth Science: Earth's composition and behavior, tectonics, geophysical processes
- Communication Skills: gain literal information from viewing

Location: Classroom

Group Size:
30 students, class size

Estimated Time: 60 minutes per activity

Appropriate Season: Any

Credits:
Group C's activity has been adapted from "Color Me Metamorphic" by Donald L. Birdd, *The Science Teacher*, April 1990, pp. 21-26.

Materials:
Part I:
Provided by the Educator:
Group A: small aquarium, sand, clay, leaves, water, pencil, "Layer on Layer" worksheet
Group B: hot plate, light corn syrup, cookie sheet, sugar, candy thermometer, water, measuring cup, raw peanuts, measuring spoons, baking soda, spatula, salt, heavy skillet, butter or margarine, "Cooking Volcano Style" worksheet
Group C: pencil sharpener, 4 crayons (each of different colors), "Hard Rock Crayola" worksheet, glitter, hammer, masking tape
Provided by park: "Metamorphic Machine"
Part II:
Provided by the Educator: "Rock Cycle" worksheet, "Rock Cycle" illustrations
Provided by park: rock specimens

Major Concepts:
- Formation of rocks
- Sedimentary rock
- Igneous rock
- Metamorphic rock
- Rock cycle

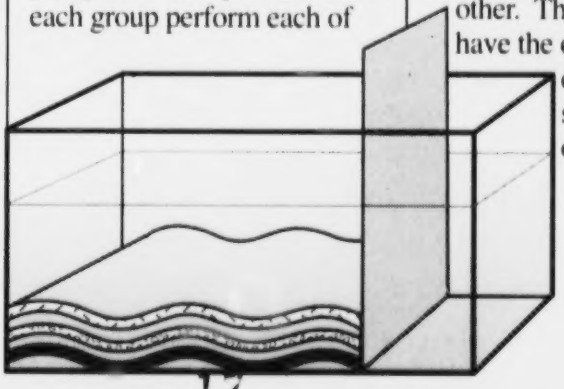
Objectives:
- Describe how sedimentary rock is formed and name two common sedimentary rocks.
- Describe how igneous rock is formed and name two common igneous rocks.
- Describe how metamorphic rock is formed and name two common metamorphic rocks.
- Describe what happens to rock when powerful forces within the Earth begin to shift, move and compress sediments.
- Describe the rock cycle and how rocks "cycle" from one rock class to the next.

Educator's Information:

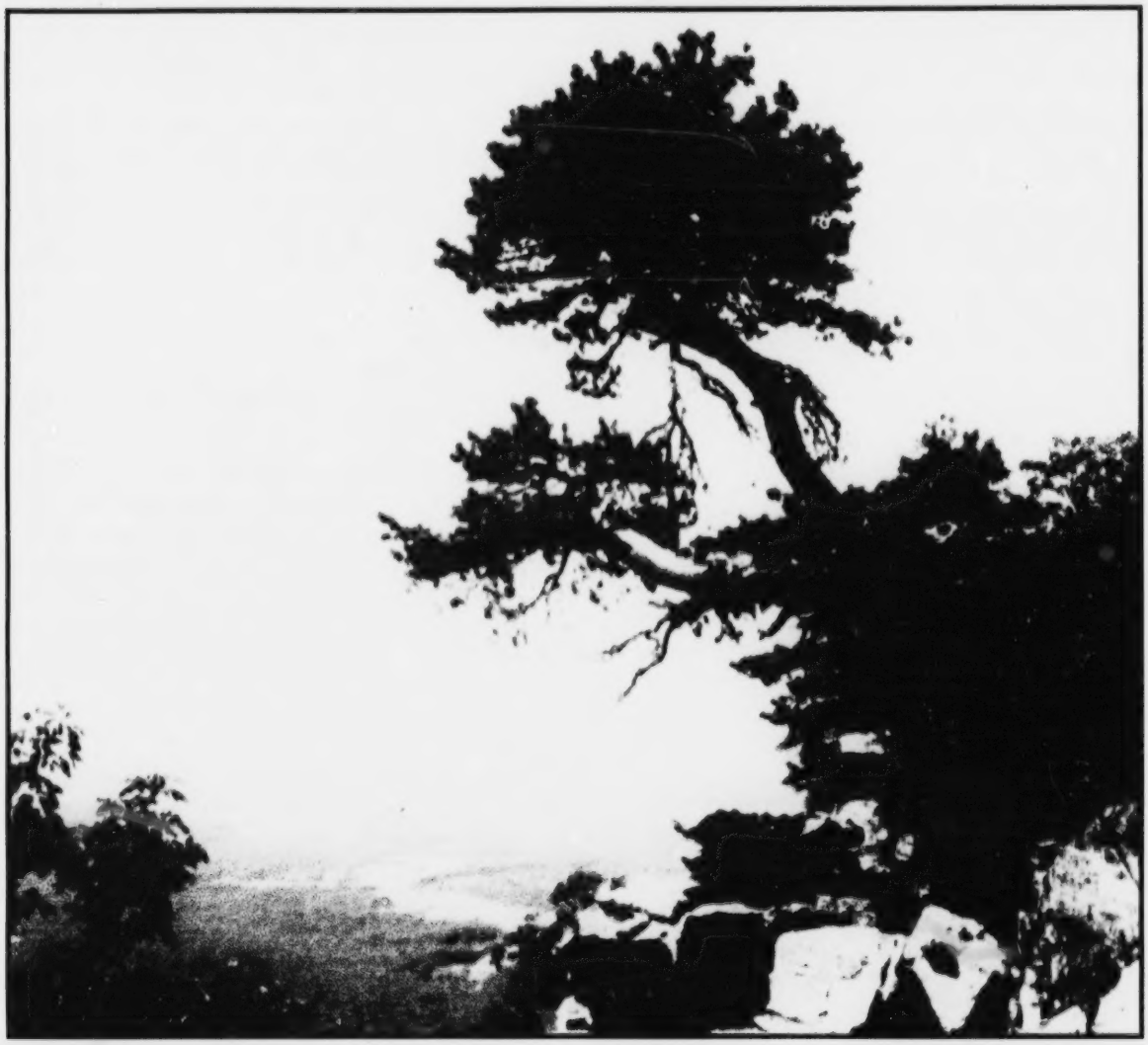
The students will simulate the formation of each of the three classes of **rock**. Divide your class into three groups. If time permits, have each group perform each of the experiments, otherwise the three groups will each perform one of the experiments, simultaneously. If the groups perform their experiments simultaneously, have them explain their experiments to the other groups. Each group should reserve some of the material they used to make their "rocks," so that the rest of the class can get a better sense of the change that occurred.

This activity has two parts. In Part I, the students simulate the formation of each of the different classes of rock. Group A will simulate the formation of **sedimentary rock** by layering sand in an aquarium. Group B will simulate the formation of **igneous rock** by making peanut brittle. Group C will simulate the formation of **metamorphic rock** by "**weathering**" a crayon (igneous rock) into sediments which eventually are compressed into "metamorphic rock."

In Part II, the students will learn how the different classes of rock are related to each other. The students will have the opportunity to examine actual samples of each of the rock classes.



Student's Information



A **rock** is an aggregate, or a composite, of **minerals**. Some rocks may consist entirely of one mineral, like a diamond, but most usually consist of a few major, or essential, minerals along with a number of minor, or accessory, minerals. Geologists have been able to put together a record of the Earth's history by learning the process by which rocks change. All rocks fall into three classes which are named according to their origin. These classes are sedimentary, igneous and metamorphic. This activity will give you the opportunity to simulate the formation of one of the different classes of rocks.

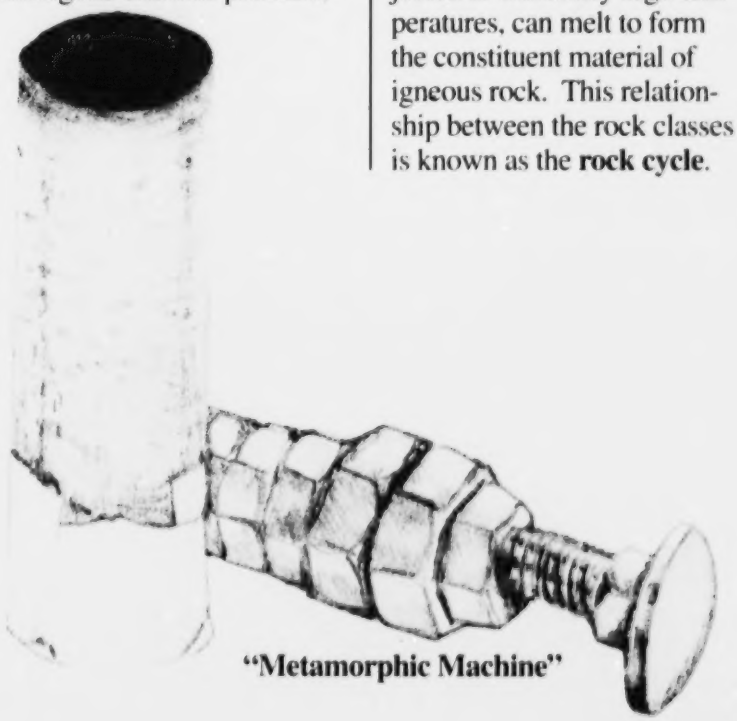
Sedimentary rocks are formed from loose **sediments**, washed into streams and rivers, that settle along the river's course or at the river's delta. These sediments may be the weathered and eroded remains of older rocks, or they may be organic, derived from living things. **Weathering** is the process which breaks down rock into sediments; it may be **mechanical**, such as abrasion or freezing, or **chemical**, when the minerals in a rock react to air or water and dissolve. **Erosion** carries the weathered materials away by wind, gravity or flowing water. As this

material piles up over time, pressure on the bottom layers increases, compacting and cementing the layers together to eventually form sedimentary rock. An example of this type of rock is sandstone. Sedimentary rock and metamorphosed sedimentary rock are the rock types in which fossils of plants and animals are found. Fossils are formed when plants and animals are surrounded by silt. The organic material in the plants and animals is slowly chemically changed to rock-type matrices. Examples of this include coal (from swamp plants) and petrified wood. Sedimentary rocks usually have a layered or bedded appearance. In fact, they may even show ripple marks or mudcracks, thus revealing the environment where they were formed.

Igneous rocks are classified by their texture, mineral content and origin. They all come from **magmas**. Magmas are molten mixtures of minerals, often rich in gases, found deep below the Earth's surface. Igneous rock has two forms: intrusive and extrusive. Intrusive igneous rock is formed when magma never reaches the Earth's surface but cools slowly within it. Granite is a good example of this type of igneous rock. Intrusive rock, such as granite, becomes exposed on the Earth's surface due to erosion of the soil and rock above it. Extrusive igneous rock is formed when magma flows or spews out of a volcano or crack onto the Earth's surface. In this stage it is called **lava**. Lava on the Earth's surface cools much faster than the intrusive form trapped beneath the surface. This difference in the rate of cooling causes different rocks to form. In texture, igneous rocks range from those with large crystals to glassy rocks with no crystals at all. Igneous rock never contains fossils. Temperatures which are high enough to melt rock are also high enough to burn up any organic matter, plant or animal, as well as fossilized rocks.

Metamorphic rocks are formed when heat and pressure change the mineral composition and grain size of igneous and sedimentary rocks. In rocks that have undergone extreme pressure, the mineral layers may be folded. An example of metamorphic rock found in the park is **quartzite**, which is a harder, more dense form of sandstone that has been metamorphosed. In fact, the whole top of Pilot Mountain is made of quartzite. Since quartzite is formed from sandstone, which is a sedimentary rock, sandstone is called the "parent rock" of quartzite.

Sedimentary, igneous and metamorphic rocks are all related to one another. Each type of rock can be weathered and eroded to form the sediment that, when compressed, will become sedimentary rock. Sedimentary and igneous rock can be changed into metamorphic rock through extreme heat and pressure. Likewise, igneous, metamorphic and sedimentary rock, when subjected to extremely high temperatures, can melt to form the constituent material of igneous rock. This relationship between the rock classes is known as the **rock cycle**.



"Metamorphic Machine"

Instructions:

1. Distribute the Student's Information to each student. After the students have read the information, discuss any questions or comments.

2. Divide the class into three groups. Group A will be responsible for the sedimentary rock simulation; Group B, for the igneous rock simulation; and the Group C, for the metamorphic rock simulation.

3. Distribute the necessary materials to each group.

4. Distribute the appropriate worksheets to each group.

5. After each group has completed its simulation, it should present its results to the rest of the class.

6. Following the group presentations, distribute the **Rock Cycle** worksheet to all students. Discuss the questions in Part II.

7. As a class, eat the peanut brittle made by Group B. This is, of course, optional.

Part I:

Set up work stations around the classroom. Review the origins and appearance of the three rock classes, then show the students examples of sedimentary, igneous and metamorphic rock. Following the review, divide the students into three groups. Have each group "make" one of the classes of rock. Following their individual activities, have each of the groups present their experiment to the rest of the class.

Group A: Layer on Layer– Sedimentary Rock

1. Fill your aquarium about halfway with water.

2. Very slowly, sprinkle some clay soil (or whatever material you are using) into the aquarium.

3. Allow all of the material to settle to the bottom. (Timing will vary depending on the material used; generally it will take about one minute.)

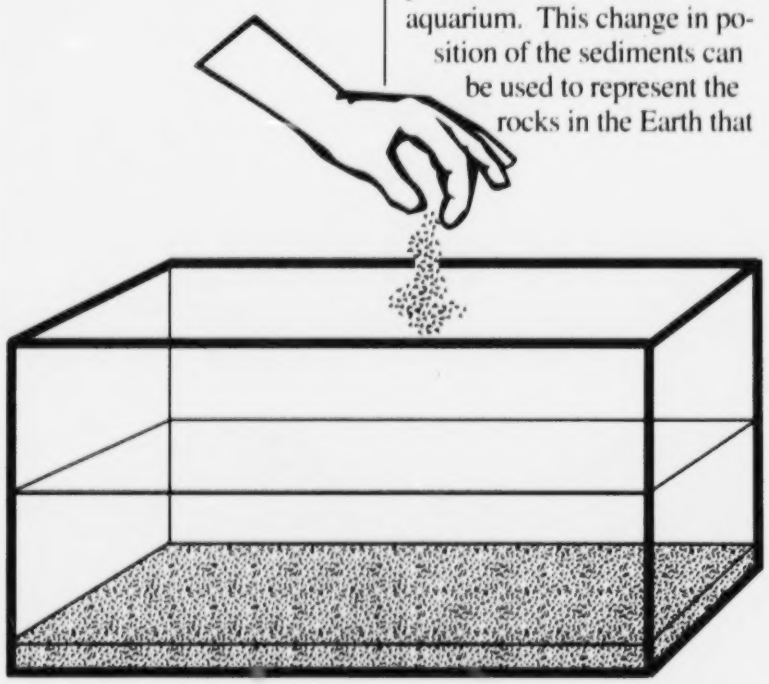
4. After the first layer has settled, add a layer of sand (the second material). Then add one or two leaves, close to the glass, to symbolize fossils embedded in the sedimentary rock. Continue making layers, alternating the clay and sand materials, until there is a minimum of eight layers. Remember to let the soil or sand settle for about a minute before adding the next layer.

5. After the final layer has settled, observe the results in your aquarium and make a sketch of the aquarium with its different layers on the worksheet (Question #1). Be sure to include the leaf fossil in your sketch.

6. Take a stiff piece of cardboard or similar material and place it through the layers to the bottom at one end of the aquarium.

7. Hypothesize what will happen to the horizontally layered sediments when you push the cardboard towards the other end. Write down your hypothesis on the worksheet (Question #2).

8. Slowly move the cardboard, horizontally pushing and compressing the layers of sand and clay. By doing this you are changing the position of the layered soil that was deposited in the still water of the aquarium. This change in position of the sediments can be used to represent the rocks in the Earth that



are folded, **faulted** and changed by movement in the Earth's crust. Folds, tilts and faults are all formations caused by crustal movements. Refer to Figure 1 for illustrations of each of these formation.

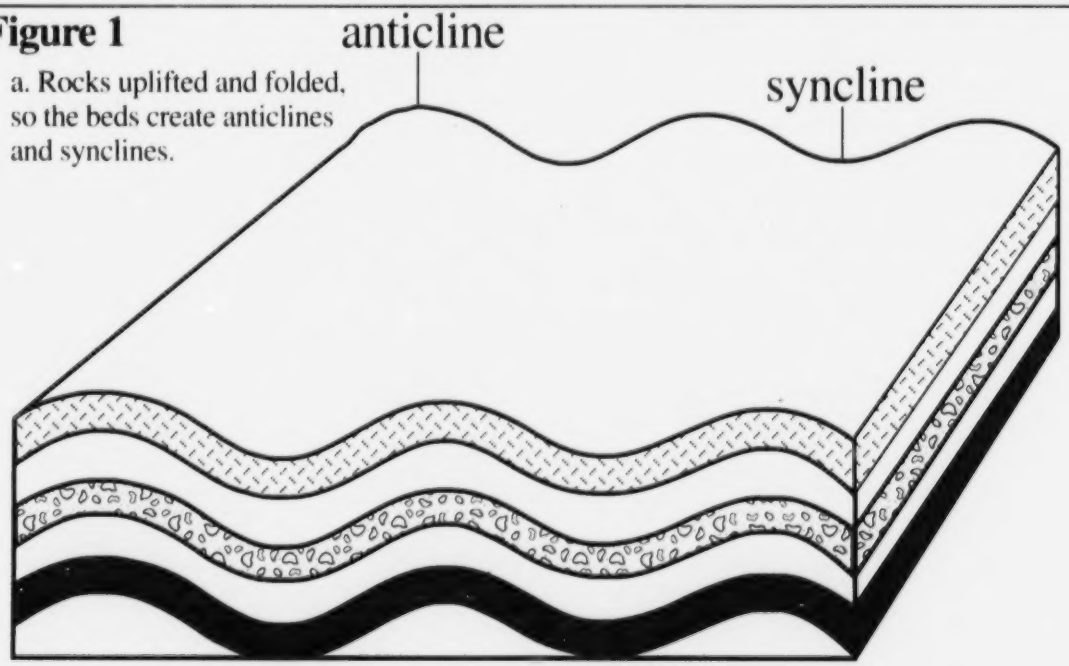
Which most closely resembles the results of your experiment? Answer Question #3 on your worksheet.

9. Draw and write down the results of this compression and label the new geologic formations by observing the folded layers through the side of the aquarium (Question #4). .

10. Complete the rest of the questions on your worksheet.

Figure 1

a. Rocks uplifted and folded, so the beds create anticlines and synclines.



b. Rock uplifted and tilted so the beds are at an angle or tilt.

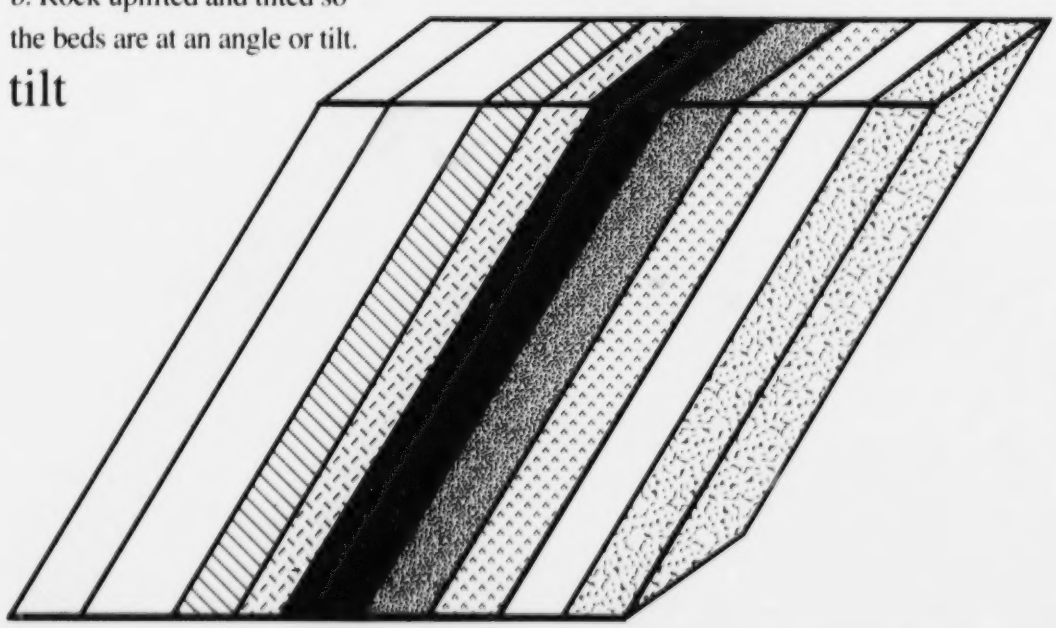
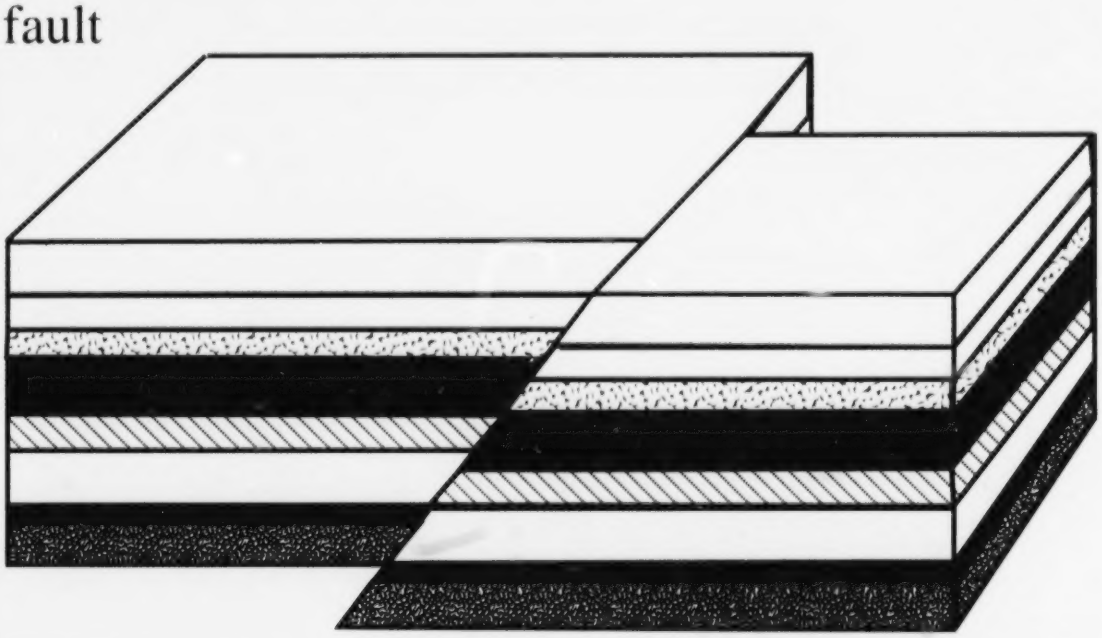


Figure 1 (cont'd.)

c. Rock shifted and broken so the beds have a fault.

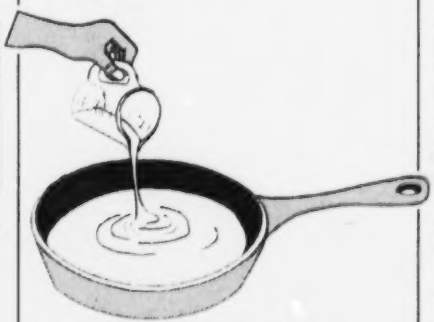


Group B:
Cooking Volcano Style – Igneous Rocks

Safety Note: This activity involves heating water and candy to high temperatures. Exercise caution, to prevent burns or scalding.

1. Prepare your **xenolith** component by blanching 2 cups unroasted peanuts (raw Spanish peanuts will not need blanching). To blanch, cover the peanuts with boiling water for 3 minutes; then run cold water over them. Remove coating. Complete Question #1 on your worksheet. Be sure to sample small amounts.

2. Grease cookie sheet. Complete Question #2 on your worksheet.



3. Measure and combine the mineral constituents (2 cups sugar, 1 cup light corn syrup, and 1 cup water) in a heavy skillet. Cook slowly, using the hot plate, stirring until the sugar dissolves. Check the temperature using the candy thermometer. (Note: Put the candy thermometer into the sugar mixture before it heats up.) Remove the skillet from the heat while testing the temperature. Cook to the soft-ball stage (238° F), which is almost cold when you consider that natural lava is heated to temperatures between 900° F and 1,200° F.

4. Add xenoliths (2 cups nuts) and an additional mineral (1/4 teaspoon salt) to the mixture and continue to heat, checking the temperature using the candy thermometer. Cook to hard-crack stage (290°), stirring constantly. Remove from heat.

5. Add the final mineral constituents (2 tsp. butter and 1/4 tsp. baking soda) and stir. Mixture will bubble, like gas escaping from a volcano. Pour onto greased cookie sheet. Cool partially by lifting around edges with spatula. Keep spatula moving under mixture so it doesn't stick. When firm but still warm, turn over. When cool, fracture, or break into pieces. Complete Question #3 on your worksheet.

6. Discuss the following points during your class presentation:

Some of the rocks that formed the Sauratown Mountains, of which Pilot Mountain State Park is a part, are the result of igneous rock formation.

Through the making of peanut brittle, this activity shows how heating and cooling changes the structure of rocks. Just as the sugar starts off as a solid and is changed by heat into a liquid, **magma** is solid rock, with sedimentary, igneous or metamorphic origins, that has been melted below the Earth's surface. When it reaches the Earth's surface it is called **lava**. The mineral content and the rate of cooling of the lava or magma determines what type of igneous rock is formed. Peanut brittle compares to igneous rock in many ways.

• They both flow very easily in their liquid state.

• Lava and magma will flow over and around rocks

just as the brittle will surround the peanuts in this activity. Rocks that are surrounded by lava but retain their integrity and are not melted are called xenoliths. In this activity the peanuts represent xenoliths.

• Both the "brittle" and lava change from a liquid to a solid, state very quickly.

• The heating and melting of the "ingredients" of both peanut brittle and rocks causes changes in them, chemically and physically.

Complete Question #4 on your worksheet.

Group C: Hard Rock Crayola – Metamorphic Rocks

Weathering

Cover all desk tops with newspaper. Make sure you have a sheet of wax paper, a pocket pencil sharpener or carrot peeler, and four crayons (each a different color). The crayons represent sedimentary, igneous and metamorphic rocks, and the pencil sharpeners represent weathering agents. Carefully shave each of the crayons with the pencil sharpener, keeping all of the fragments in a small pile.

Erosion and Sedimentation

Once the rocks have been fragmented, they are usually moved by some force of **erosion**, like gravity, moving water and wind. Here, you act as the erosive force. Place all the weathered rock fragments in four separate piles, one color to a pile. Take the bolt out of the middle of the "Metamorphic Machine". Cover one end of the pipe with masking tape and then carefully put in one layer (same color) of weathered sediments about 1/2 inch deep. Add an additional layer of different colored weathered sediment. Next sprinkle some glitter on top of the second layer. Add the last two remaining layers both of different colors, like you did before.

Record your observations by completing Question #1 on the "Hard Rock Crayola" worksheet.

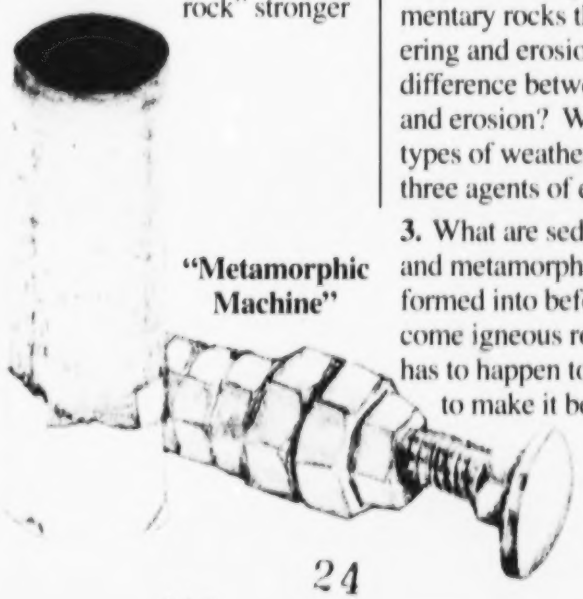
Sediments/Sedimentary Rock Simulation

Put the bolt back into the pipe with the large end touching the sediment inside the pipe. Now, press the other end of the bolt as hard as you can with your hand. Be sure the end of the pipe (with the masking tape) is resting flat on the table. After you have compressed it as much as you can ***using only your hand***, carefully remove the tape from the bottom of the "Metamorphic Machine". Slowly, push your "sedimentary rock" out the bottom. Answer question #2 on the worksheet.

Metamorphic Rock Simulation

Carefully put your "sedimentary rock" back into the pipe. Replace the tape on the bottom and put the bolt back in the top. Place the "Metamorphic Machine" so that the bottom (covered with masking tape) is flat on the floor. To change your "sedimentary rock" into "metamorphic rock", much more pressure will have to be exerted. Therefore, *using the hammer*, compress the bolt into the pipe as hard as hard as you can. In reality, as the pressure deep within the Earth increases to make real metamorphic rocks, the temperature increases as well. A temperature change is probably occurring in this activity, but can't be measured.

Remove your "metamorphic rock" from the pipe and carefully slice it down the middle so the layers can be seen. Notice the layer of glitter you added. This symbolizes layers of mica. Is your "metamorphic rock" stronger or weaker along the mica layer? Answer question #3 on your worksheet.



"Metamorphic Machine"

Remember that metamorphic rock may become contorted in appearance. It may actually flow like a plastic material in response to the pressure from the rock load above and **crustal plate** movement.

Place the newly-made "metamorphic rock" with the "sediment" fragments and the "sedimentary rock" previously saved aside to share with the rest of the class.

Part II:

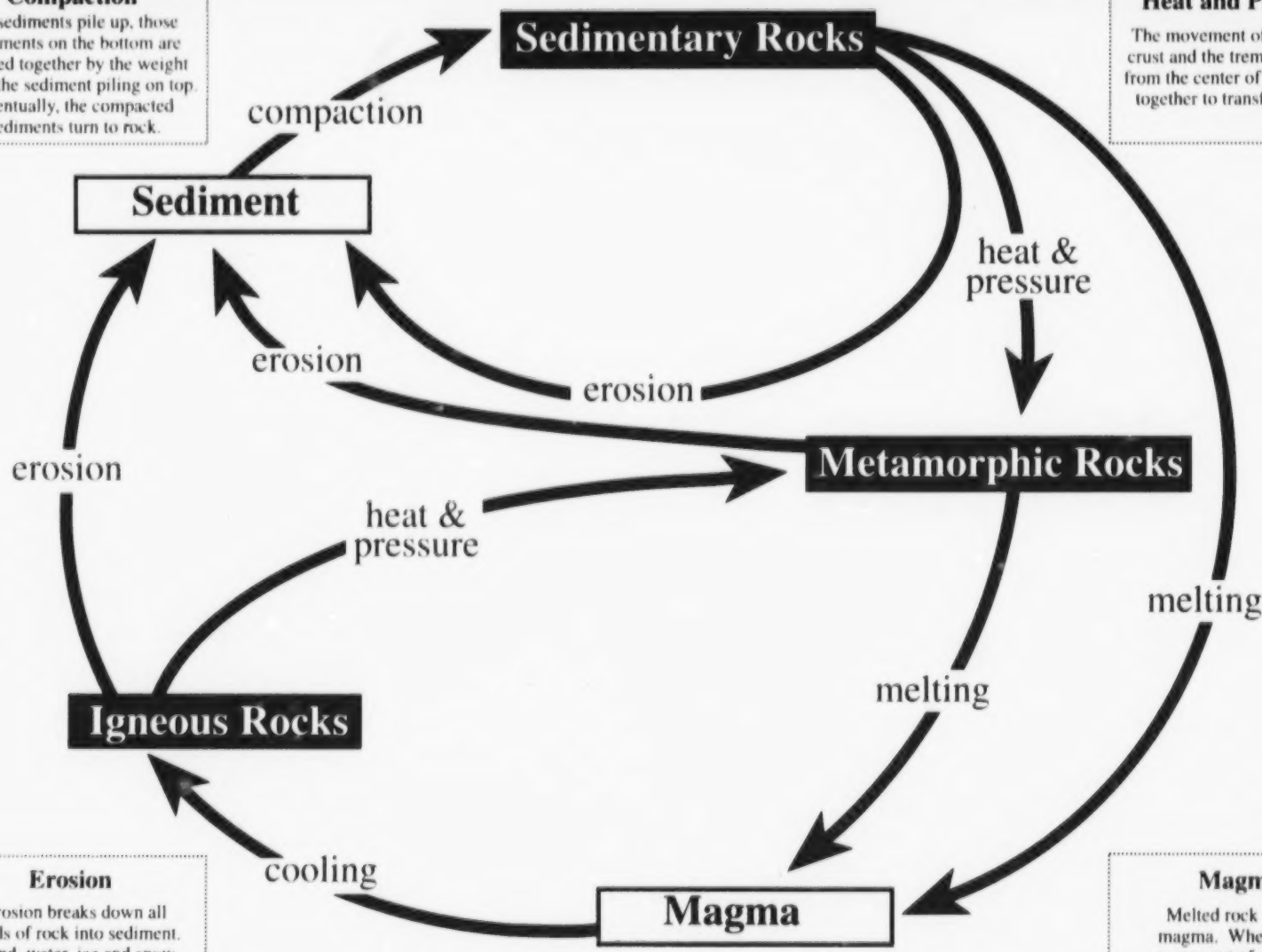
Following the demonstrations, examine the Rock Cycle Worksheet and notice the interrelationship between the three different rock classes. Discuss the following questions with the rest of the class:

1. What are the two things necessary to change igneous rocks into metamorphic rocks? What causes these forces?

2. Metamorphic and igneous rocks are changed into sedimentary rocks through weathering and erosion. What is the difference between weathering and erosion? What are the two types of weathering? Name three agents of erosion.

3. What are sedimentary and metamorphic rocks transformed into before they become igneous rocks? What has to happen to this material to make it become a rock?

Rock Cycle Worksheet



Compaction
As sediments pile up, those sediments on the bottom are packed together by the weight of all the sediment piling on top. Eventually, the compacted sediments turn to rock.

Heat and Pressure
The movement of the earth's crust and the tremendous heat from the center of the earth act together to transform rocks.

Erosion
Erosion breaks down all kinds of rock into sediment. Wind, water, ice and snow all cause erosion.

Magma
Melted rock is called magma. When magma comes out of a volcano, it is called lava.

August 1994
3.1.9
Pilot Mountain State Park, NC

Group A: Layer on Layer Worksheet

1. Draw the newly formed "sedimentary rock" with fossil.

2. What do you hypothesize will happen to the horizontally layered sediments when pressed from the side?

3. What actually happened?

4. In the space provided at the bottom of the page, draw the compressed "sedimentary rock" and label the geologic formations created by this process.

5. Label the layer which is the oldest.

6. Label the layer which is the youngest?

7. Why are the layers deposited in parallel layers?

8. Can the sediment be evenly layered on a slope?

9. Can the sediment be layered vertically?

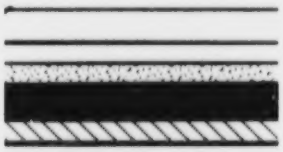
10. If the layers are shifted before they solidify, what happens?

11. What happens when the layers are shifted after they solidify?

12. What do the leaves represent?

Group A: Layer on Layer Answer Sheet

1. Draw the newly formed "sedimentary rock" with fossil.



2. What do you hypothesize will happen to the horizontally layered sediments when pressed from the side? *The sediment layers folded and became rippled.*

3. What actually happened?

4. In the space provided at the bottom of the page, draw the compressed "sedimentary rock" and label the geologic formations created by this process.

5. Label the layer which is the oldest. *bottom layer*

6. Label the layer which is the youngest? *top layer*

7. Why are the layers deposited in parallel layers? *Due to gravity and the even distribution of sediments in still water.*

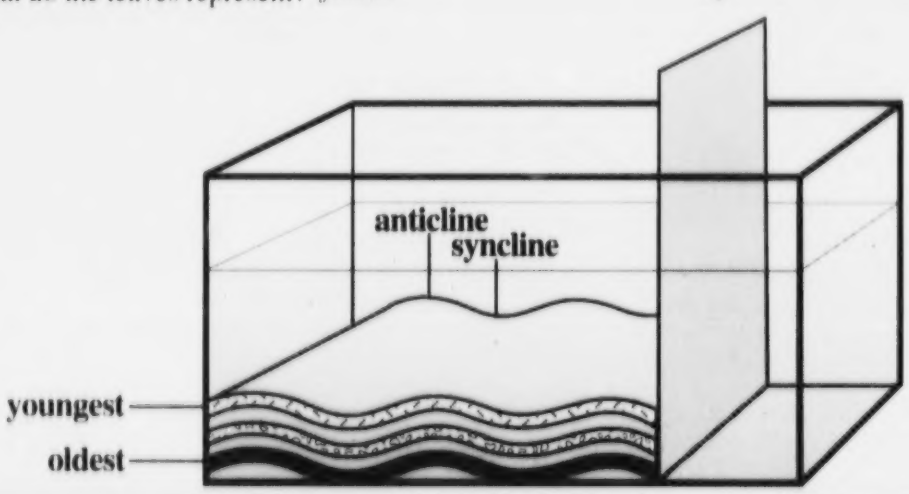
8. Can the sediment be evenly layered on a slope? *no*

9. Can the sediment be layered vertically? *no*

10. If the layers are shifted before they solidify, what happens? *They get jumbled and do not show layers clearly.*

11. What happens when the layers are shifted after they solidify? *They fold and fault.*

12. What do the leaves represent? *fossils*



Group B: Cooking Volcano Style

1. Take a small (less than 1/8 tsp.) taste of each of the peanut brittle constituents. These represent the different minerals that make up a sample of igneous rock.

Constituent	Taste Description
sugar	
syrup	
water	
butter	
nuts	
salt	
baking soda	

2. Draw the "igneous rock" prior to applying heat to liquefy it. Try to show the "mineral constituents" in the drawing.

3. Draw the "igneous rock" after heat has been applied, the gases escaped and the "lava" cooled. Be sure to show "xenoliths."

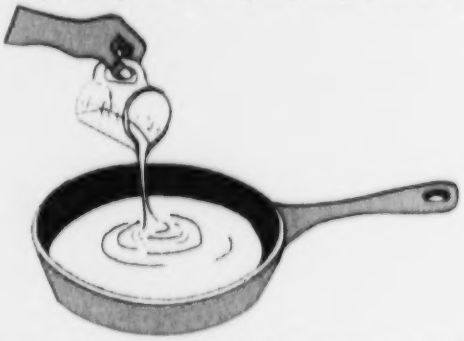
4. Describe how the "rock" changed chemically and physically in structure, texture and taste.

Group B: Cooking Volcano Style Answer Sheet

1. Take a small (less than 1/8 tsp.) taste of each of the peanut brittle constituents. These represent the different minerals that make up a sample of igneous rock.

Constituent	Taste Description
sugar	*sweet*
syrup	*sweet*
water	*plain*
butter	*greasy and salty*
nuts	*nutty*
salt	*salty*
baking soda	*bitter*

2. Draw the "igneous rock" prior to applying heat to liquefy it. Try to show the "mineral constituents" in the drawing.



3. Draw the "igneous rock" after heat has been applied, the gases escaped and the "lava" cooled. Be sure to show "xenoliths."

4. Describe how the "rock" changed chemically and physically in structure, texture and taste.

The different mineral constituents became one unified rock. It had a fairly smooth texture, except for the xenoliths. It does not taste like any single constituent, although the taste most resembles sugar.

Group C: Hard Rock Crayola Worksheet

1. Describe and draw the sediments that you weathered.

2. Draw a color picture of the rock fragments after light pressure has compacted these sediments into sedimentary rock. Describe the broken edge and the layers that are formed.

3. Draw a color picture of the metamorphic rock. Describe the broken edge and the layers that are formed. How have they changed with the addition of heavy pressure?

Group C: Hard Rock Crayola Answer Sheet

1. Describe and draw the sediments that you weathered.

2. Draw a color picture of the rock fragments after light pressure has compacted these sediments into sedimentary rock. Describe the broken edge and the layers that are formed.

3. Draw a color picture of the metamorphic rock. Describe the broken edge and the layers that are formed. How have they changed with the addition of heavy pressure?

On-Site Activity #1 — Rock Around the Knob

Curriculum Objectives:
All Grades:
- Earth Science: Earth's composition and behavior, tectonics, geophysical processes, location and mapping, pollution climatic (air) effects, environment
- Communication Skills: gain literal information from viewing
- Guidance: draw reasonable conclusions from information found in various sources

Location:
Summit Area, Jomeokee Trail at Pilot Mountain State Park

Group Size:
30 students or less, class size (Ratio: 1 instructor per 10 students)

Estimated Time:
45 minutes to 1 hour

Appropriate Season: Any

Materials:
Provided by the park: rock and mineral specimens found at Pilot Mountain State Park, examples of the three basic rock types
Per student: magnifying glass, pen/pencil, paper, clipboard
Provided by the educator:
Per student: Geology Field Guide

Major Concepts:
- Rock formation
- Rock properties
- Weathering and erosion
- Topography and mapping
- Landforms

Objectives:
- Hypothesize the geologic history of Pilot Mountain by learning about specific land forms and rock types.
- Identify one type of rock formation that indicates tectonic plate activity.
- Observe and list seven examples of weathering.
- Explain the difference between chemical and mechanical weathering.
- Observe and explain two geologic formations that indicate a past aquatic environment.
- Identify seven rocks and minerals that are common to Pilot Mountain.

Educator's Information:

The activity, "Rock Around the Knob," takes students on a 3/4 mile hike on a rocky trail called the Jomeokee Trail. At 15 numbered stops, the students will study and answer corresponding questions in their **Geology** Field Notebook. Students can work independently and do not necessarily have to walk the trail in chronological order as long as the stop number corresponds to the correct stop number in the field guide. They should finish the 13 numbered stops on the trail first. The activity will finish at the Little Pinnacle Overlook where the students will complete stops #14 and #15.

The trail begins at the Jomeokee Trail sign and slopes downward along the northern base of the Little Pinnacle. It then levels off in the "saddle" area and begins to ascend towards the Big Pinnacle. The trail continues around the Big Pinnacle, returning to the conjunction of the trail just above the "saddle" area. At this point the trail takes you back to the head of the Jomeokee Trail. The Little Pinnacle Trail begins approximately fifty feet to the left and leads approximately two hundred yards to the overlook area.

You may want to divide students into teams consisting of three to four students. ***Stress trail safety at all times.***

Instructions:

1. Prior to arriving at the park, copy the Geology Field Notebook for each student.

2. Take the students to the beginning of the Jomeokee Trail. Review with the students the following park rules and regulations.

a. Be as quiet as possible while in the park. This will help you get the most out of the experience and increase your chance of observing wildlife.

b. Rock climbing is not permitted. No rocks are to be removed from the park.

c. All plants and animals within the park are protected. Injuring and removing plants or animals are prohibited in all state parks. This allows future visitors the same opportunity to enjoy our natural resources.

d. Help keep the park clean and natural by not littering and by properly disposing of any litter you find.

e. *In case of accident or emergency, contact park staff immediately.*

3. Distribute a Geology Field Notebook, clipboard and pencil to each student. The students need to hike along the Jomeokee Trail, stopping at each of the 13 numbered stops. Each stop is described in the notebook. After completing the 13 stops, the students should proceed to the overlook area on top of Little Pinnacle. There they should complete the numbered stops relating to the Little Pinnacle overlook.

4. At the conclusion of the activity, as a class, discuss the students' observations and answers.

GEOLOGY FIELD GUIDE

PILOT MOUNTAIN STATE PARK

August 1994

4.1.3

Pilot Mountain State Park, NC

Pilot Mountain State Park, NC

August 1994

2. Imagine you have been hired as a park designer. Turn to the topo map in your field notebook. You are responsible for deciding where to put a road, picnic area, parking lot, two trails, campground and restroom. Remember that most of these areas will have to be in relatively flat areas. Trails and roads should be placed so they run parallel to contour lines, rather than crossing them at right angles. Think which facilities should be close to one another, and which should be separated. For instance, you probably do not want the hiking trails to cross the road–so that the hikers will not be hit by a car.

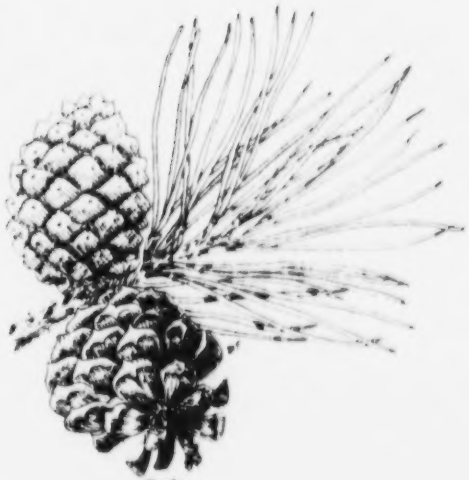
Now draw a road, picnic area, parking lot, two trails, campground and restroom on th topographic map.

3. Explain why you located each of the facilities in their particular places.

Stop #15 Topography

Topographic, or topo, maps can give you a tremendous amount of information about an area. The thin lines on the map indicate a change in elevation, or how high an area is above sea level. Each contour line indicates a 20' change in elevation. If the contour lines are very far apart, it shows that the area is relatively flat. On the other hand, closely-spaced contour lines show a lot of change in elevation in a short distance–in other words, a steep slope.

1. Determine the height of Big Pinnacle by looking at the topo map on page 23.



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Welcome to Pilot Mountain State Park, an outdoor museum covering one billion years of geologic history. Today, you will be hiking along the Jomeokee Trail to see if you can unlock some of the mysteries of Pilot Mountain. As you look around the mountainous environment of Pilot Mountain State Park, realize that this area did not always look this way. Your mission on your hike is to unearth clues to what other environments used to exist here. Geologists are really detectives who study **rocks** for clues to the past. Each of the stops on the trail will hold clues to the past, and maybe the future. However, no stop will hold all of the clues. By taking careful notes in your field notebook, you will be able to put together a history of this area by the time you finish your hike.

A field notebook is one of the most valuable tools used by a geologist. It is important to write down as much information as possible while on the site, actually looking at the rock formations. If you just jot down a short note, it will be confusing by the time you get back to your desk. Try to draw as many pictures as possible. The old saying, "A picture is worth a thousand words," is certainly true in **geology**.

Along the Jomeokee Trail there are 15 stops. The last two are located at the overlook on the top of Little Pinnacle. Complete the first 13 stops around Big Pinnacle, and then go to the Little Pinnacle overlook to complete the last stops. Each stop illustrates the effect of at least one **geologic process**. Be sure to visit each stop and answer all the questions in your field notebook. Remember, you are in a state park. All plants, animals and rocks are protected. Do not pick any plants, or parts of plants. Also, if you pick up a rock to examine it, put it back where you found it.

Good luck in unlocking the secrets of Pilot Mountain.

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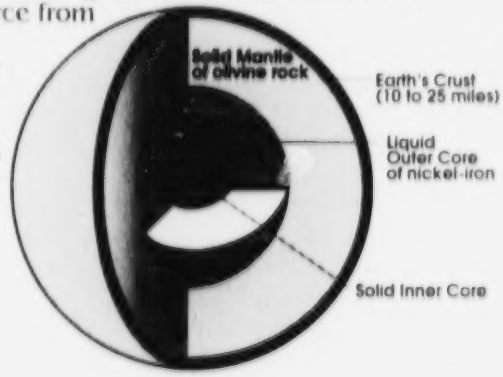
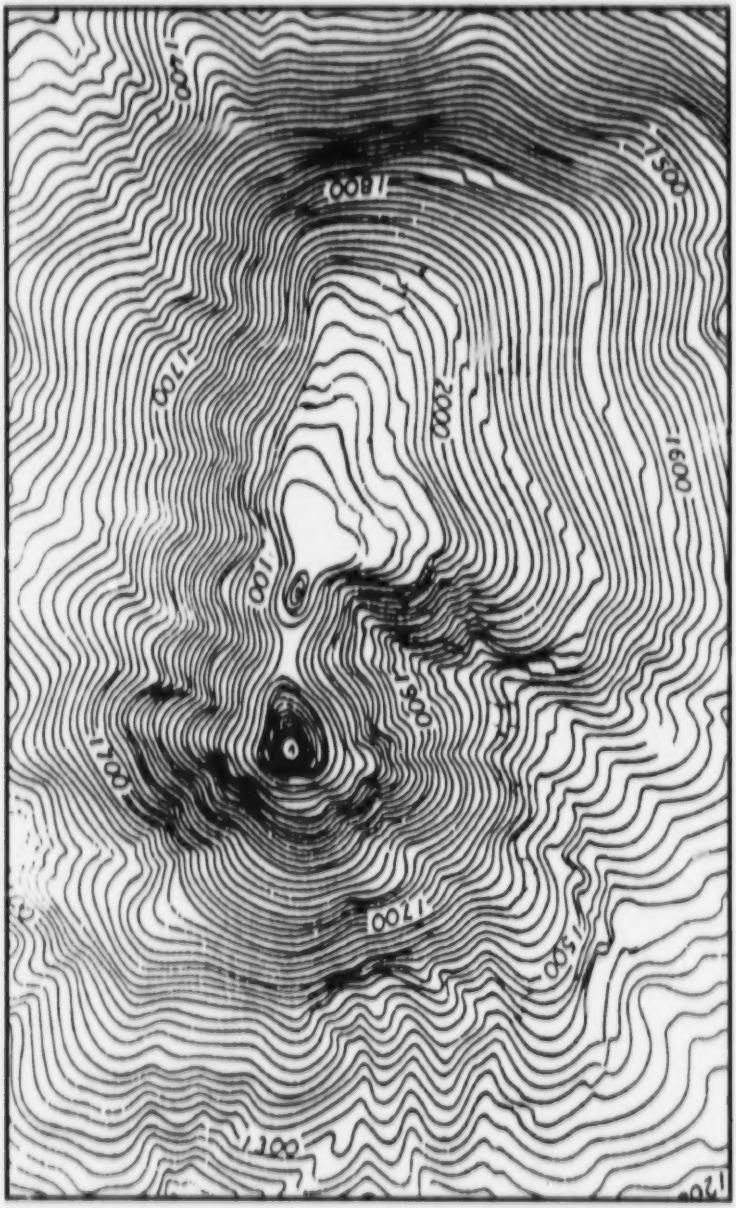
Stop #1 Crenulations

Look at the picture of the different layers of the Earth. The evidence left at this stop is from a geologic process that involves the very top layer–the crust. The crust is made up of large sections known as tectonic plates. These plates are moving, although most of the time, too slowly for us to notice. However, sometimes the effects of these movements–earthquakes and volcanoes are very noticeable. Clues that plates have moved in the past are left in the rocks. Sometimes when two tectonic plates have pushed against each other, one plate is pushed down, while the other plate is forced up. This is one way mountains form. Many times, the rocks that are caught in the middle when this is happening are actually folded from the immense pressure.

Imagine putting a tablecloth on your dining room table. Now, in your mind, push the tablecloth across the table–notice how the tablecloth develops wrinkles at right angles to the direction you are pushing. This is how it works in rocks too. Look closely at the wavy layering in the rock. These waves, or **crenulations**, are evidence that rocks were folded during the millions of years that the tectonic plates were colliding. Remember, mountains are not formed (or eroded) overnight, it takes thousands or millions of years. In addition to folding individual rocks to cause the crenulations, the force from the tectonic plates pushing against one another actually caused the countryside to fold, producing the Sauratown Mountains. These folds in the landscape are called the Sauratown **Anticlinorium**.

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3. Make a list of the environments that have existed here and write down at least one clue, from your field notebook, that supports your hypothesis.

4. Look at the list of the environments that you made in Question #3. Rank them in order from oldest to youngest. Why did you choose this order? (Hint: The present environment is the youngest.)

1. Draw the crenulations you see in the rock.

2. Remember the tablecloth example. On your drawing, draw arrows to indicate which direction(s) the force was applied to produce the folds.

3. Notice the soil. It will be compared to the soil at stop #2.

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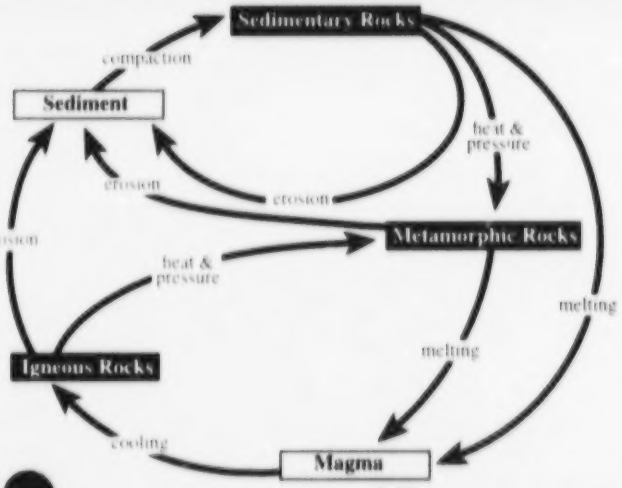
Stop #2 The Saddle

This area is called "the saddle" because it is a dip between the two pinnacles–sort of like the shape of a saddle for a horse . Compare the soil here with the ground in Stop #1. The radically different soil is a result of millions of years of **weathering**.

The breakdown of rock by wind, water and frost is known as **mechanical weathering**. (Rocks can also be broken down chemically in the process of **chemical weathering**.) After rocks are broken down by the weathering process, they are often removed by other **erosion** factors, such as gravity, wind and water.

This area used to be as high as the two pinnacles, but was made of rock that was not as strong as the **quartzite** that makes up the tops of the two pinnacles. As soon as a rock is exposed on the surface of the Earth, it is subjected to weathering and erosion that in time (thousands or millions of years) will flatten it. Weathering is a very important part of the **rock cycle** because it produces the **sediment** to make new **sedimentary rocks**.

Rock Cycle Worksheet



1. Sketch a panoramic view. Include all of the Sauratown Mountains, to the NE, the layering on Big Pinnacle, the Stony Ridge Fault, Yadkin River and the Blue Ridge Mountains, to the SW. The sketch does not have to be to scale.

2. Refer to Stop #13 and see if any of those trees are growing around this overlook. List which ones are present and note in which compass direction they lie.

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Stop #14 Little Pinnacle Overlook

Begin by orienting yourself at the overlook. As you look straight ahead at Big Pinnacle, you are facing east. Notice the layers in the rock that makes up Big Pinnacle. As you learned at Stop #7, the layers are a clue that a beach environment may have been in this spot at one time. You may see some large black birds circling Big Pinnacle. These are vultures, who are year-round residents of Pilot Mountain. Look slightly to the left of Big Pinnacle to see two other mountains. The closest one is Sauratown Mountain. The farther mountain, with two peaks is in Hanging Rock State Park. The left peak is Moore's Knob and the right one is Cook's Wall.

Turn your field notebook so that the east arrow on the compass points to Big Pinnacle. Now, you should be able to determine where north, south and west lie. Look north to the mountains on the horizon. These are the Blue Ridge Mountains which lie mostly in Virginia. From this point you can see why the Sauratown Mountains are called "the mountains away from the mountains." Winston-Salem lies to the south of the overlook. Is it clear enough to see any of the tall buildings? They are about 25 miles away. Between you and Winston-Salem runs the Yadkin River. It looks like a thin line of muddy water. The Yadkin River begins near Blowing Rock, NC and empties into the Atlantic near Georgetown, SC.

Look for a small ridge southwest from you. This is the Stony Ridge Fault. A **fault** is a crack in the rocks. It shows where rocks have moved against each other. This fault extends 43 miles across the Piedmont and is further evidence of the Earth-moving activity that once occurred here.

1. Color in the arrows in the rock cycle that apply to processes that are represented at this stop.

2. Pick up a handful of sand and hold it up to the sunlight. Notice the shiny flecks? These are pieces of the **mineral**, **mica**.

3. Draw a picture of what this area may have looked like millions of years ago before weathering affected any of the rocks.

4. Now, draw the outline of the two pinnacles over the drawing you did in question #3. Where do you think all the weathered sediments went?

Stop #3 Rotten Rock

Notice the soft layered material along the trail. This is called saprolite, or rotten rock and it is in the final stages of being weathered, or broken down into sediments. It is almost like you moved back in time from Stop #2 because this is what the rock looks like before it turns into sediment, like in the Saddle. This shows us that weathering is still affecting Pilot Mountain.

1. Name at least three things in nature that would weather rocks at Pilot Mountain.

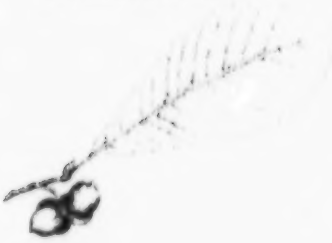
2. Are there any ways that people can weather rocks?

3. Take a small piece of saprolite and crush it in your hand. What happens?

pitch pine

Catawba rhododendron

chestnut oak



mountain laurel

2. Which of these plants can you find around your home or school?

After you complete the first 13 stops, go to the overlook at the top of Little Pinnacle. Refer to your trail map for directions if necessary.

Stop #13 Plants & Geology

The types of plants located in a particular area are directly related to the area's geology and how the land has been shaped over the years. The soil type, elevation, latitude, slope and compass direction the slope faces and topography all affect the plant communities that will grow in a given location. For example, the pitch and table mountain pines prefer to grow at higher elevations, typically with almost no soil.

1. Based on the drawings below, find an example of each plant pictured. Do not pick any leaves on any of the plants.

sourwood

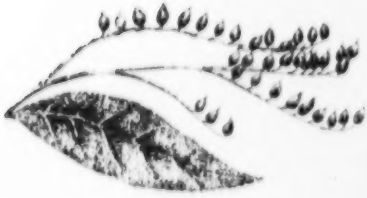


table mountain pine

51

Stop#4 Big Pinnacle

Look up to the top of Big Pinnacle, or the Pilot. At this point, Big Pinnacle is about 125' high, with about 2 1/2 acres on the top. Ravens and vultures nest on the top, which is one reason nobody is allowed to climb on Big Pinnacle. This rock formation is called an **monadnock** – an isolated rocky hill, or mountain, that rises above the surrounding countryside. This formation is made of quartzite, a rock that is very resistant to weathering and erosion. As weathering and erosion disintegrated softer rocks, the quartzite did not break down as easily.

At one point, this whole region was a **peneplain**, or flat area. The Big and Little pinnacles are the result of millions of years of mechanical and chemical weathering. Weathering is the breaking down of rock by the action of water, ice, plants and chemicals. Weathering wears down all rocks but at different rates. Examples of mechanical weathering are: ice wedging, water seeping into cracks in the rock and freezing, the expansion causing the rock to split; and root destructions, plants growing in crevices and cracks which apply pressure to the rocks causing the cracks to widen. Chemical weathering occurs when some minerals in the rock react with the air and water, dissolving the materials holding rocks together.

Look around you and see if you can find large rocks laying on the ground. These were broken off the side of Big Pinnacle. When large rocks like these fall, it is known as **mass wasting**. Mass wasting is another result of mechanical weathering. As some of the softer minerals holding these rocks to the side of the Pilot are weathered away, eventually the pieces will fall.

1. Do you think these rocks fell recently? (Hint: Is there any sediment accumulated around the base of the fallen rocks? This could be a sign that weathering has occurred since the rocks fell.)

2. Draw a picture of a rock in your notebook. Now draw a picture of the various forces that can mechanically weather your rock. Next, draw a picture of what your rock will look like after being weathered for millions of years.

Stop#12 Chlorite Mica

Locate the numbered rock. Carefully examine the green material on the top of the rock with your hand lens. This is a mineral known as chlorite mica. Minerals are the building blocks of rocks. The major difference between rocks and minerals is that minerals have definite chemical compositions and atomic structures, while the chemical compositions and atomic structure of rocks can vary somewhat. Most minerals will form crystals, if given the right condition. Rocks are made up one, or more minerals. A helpful analogy is to think of a rock as a fruitcake. The nuts and fruits in the fruit cake would represent minerals.

Hypothesize why the numbered rock fell.
(Hint: Remember Stop #4.)

54

Stop #11 Mechanical Weathering: Tree Style

At Stop #8, you learned how joints in the rocks are formed. At this stop, you can see how trees take advantage of these joints. As the tree grows, the roots expand, eventually breaking off more rock. This particular form of mechanical weathering is known as root destruction.

1. Why would roots "choose" to follow the joint?

2. Sketch a picture of the mechanical weathering at this stop. Is this form of weathering still occurring? Why or why not?

55

Stop #5 Conglomerate

Look at the numbered rock. This type of rock is called a **conglomerate**. Conglomerates are made of different types of rock materials that are cemented together in running water. They are found in ocean and river environments. Now take out your magnifying glass and look closely at the blue, glassy material in the conglomerate. This is blue **quartz**. Quartz is a mineral, and like all minerals, has a typical environment in which it is formed. Quartz often originates in **igneous rocks**.

1. What might the presence of the conglomerate tell us about the geologic history of Pilot Mountain?

2. Presently, there are no igneous rocks at Pilot Mountain. Yet, there is quartz here. Where are the igneous rocks that would have produced this mineral? (Hint: Think of the rock cycle.)

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Stop #6 Chemical Weathering

We have seen the effects of mechanical weathering at some of the other stops. Here is an example of another type of weathering–chemical weathering. Chemical weathering is the gradual disintegration of rock by chemical action. A common type of chemical weathering today is acid precipitation. Pure rainwater is naturally acidic. However this effect is increased with acid rain. Acid rain, acid snow and acid fogs are produced when emissions from cars and factories go into the atmosphere and produce acidic compounds. These compounds come back to the Earth in the form of rain, snow and fog. Certain minerals are broken down by these acids. As these minerals are disintegrated, other minerals in the rocks are loosened and fall out.

In addition to weathering rocks in nature, acid precipitation is destroying many of our national treasures. Locations as diverse as Mt. Rushmore and the monuments in Washington, DC, as well as buildings and statues around the world, have shown the effects of acid precipitation.

Nature also produces acidic compounds. Look at the stuff that looks like a fungus on the rocks. This is a form of **lichen** known as rock tripe. Lichens are unique organisms that are a combination of a fungus and an alga. These organisms secrete an acid while attached to the rocks. Scientists are unsure why, but suspect this may help them remain attached to the rock. In any event, this acid will also eventually weather away the rocks.

Stop #10 Devil's Den

Devil's Den was carved by the force of moving water. Remember what crossbedding indicates about past environments. Can you find any evidence of crossbedding here? One of the most interesting features of this stop is the small cave that is just above and to the left of Devil's Den. Climb up to feel the wind coming out of the cave. The cave extends all the way to the top of Big Pinnacle. The air movement is caused by the difference in air temperatures inside the cave and on the top of Big Pinnacle. In the summer, the air temperature is cooler inside the cave. As the cool air sinks, more air is pulled into the top of the cave. This air also cools and falls once it is inside the cave and shielded from the sun. In the winter, the air inside the cave is warmer than the air outside.

1. Which direction would the air flow in the winter. Remember, warm air rises and cool air falls.

2. Draw a diagram that shows the air movement through the cave in the summer.

58

Stop #9 Mineral Colors

As rocks weather, different minerals are exposed. One of the characteristics that is used to identify minerals is color. By looking carefully here with your magnifying glass, you can see manganese (black), quartz (glossy white) and muscovite mica (shiny). You can also see the effects of oxidation–the combination of oxygen with certain minerals. In this case, the mineral is iron which combined with oxygen to form iron oxide, or rust. This material is tan or rusty colored. Oxidation is a major cause of the breakdown of iron.

1. Which mineral that you identified by color is most common at this stop?

2. Oxygen combines with iron to form iron oxide. Is this a form of mechanical or chemical weathering? Why?

3. Observe all of the small indentations and tunnels. How do you think these formed?

59

1. Write a poem about the weathering of the rocks at Pilot Mountain.

2. What are other effects of acid precipitation on the environment?

60

Stop#7 Crossbedding

Notice the dark lines in the rock. See how they run parallel and then are almost at right angles to each other. This is what is known as **crossbedding**. The layers in the rock were caused by layers of sediments being deposited in a shore or near shore environment. The area where the lines are not parallel is evidence that the rock was formed of sediments pushed or piled up during a major storm event.

1. This area has undergone many changes in the last 1 billion years. What type of environment is indicated by crossbedding?

2. Draw a picture of what this environment may have looked like.

Stop #8 Joints

Notice the large vertical cracks in the rocks. These are called **joints** and were formed by the same action that caused the crenulations in Stop #1. Another way that joints can be formed is by the expansion of rocks as the top layers erode away, thus relieving pressure on the lower rocks. Look at the rocks that seem to be standing by themselves. See if you can match up the layering in these rocks with the surrounding rocks. The layers fit together. In this case, the material that filled the joints was softer than the surrounding rock. Over a long period of time, this material eroded away, leaving the joints.

1. What might be a possible effect of having joints in the rock? (Hint: Remember Stop #4.)

2. Draw a picture of one of the joints. Be sure to include the layering in the surrounding rocks.

62

Post-Visit Activity #1 — Geo-crossword

Curriculum Objectives:
All Grades:
- Earth Science: Earth's composition and behavior, tectonics, geophysical processes.
- Communication Skills: vocabulary

Location: Classroom

Group Size:
30 students, class size

Estimated Time: 30 minutes

Appropriate Season: Any

Materials:
Provided by the educator:
Per student: crossword puzzle, pen/pencil

Major Concepts:
- Formation of rocks and minerals
- Classes of rocks and minerals
- Geologic processes
- Rock formations

Objectives:
- Name the three rock types and the process by which they change from one to another.
- Know the difference between weathering and erosion, and the major agents causing each.
- Name three types of weathering.
- Name four geologic formations found at Pilot Mountain State Park.

Educator's Information:

The purpose of this activity is for review of vocabulary words used throughout the packet.

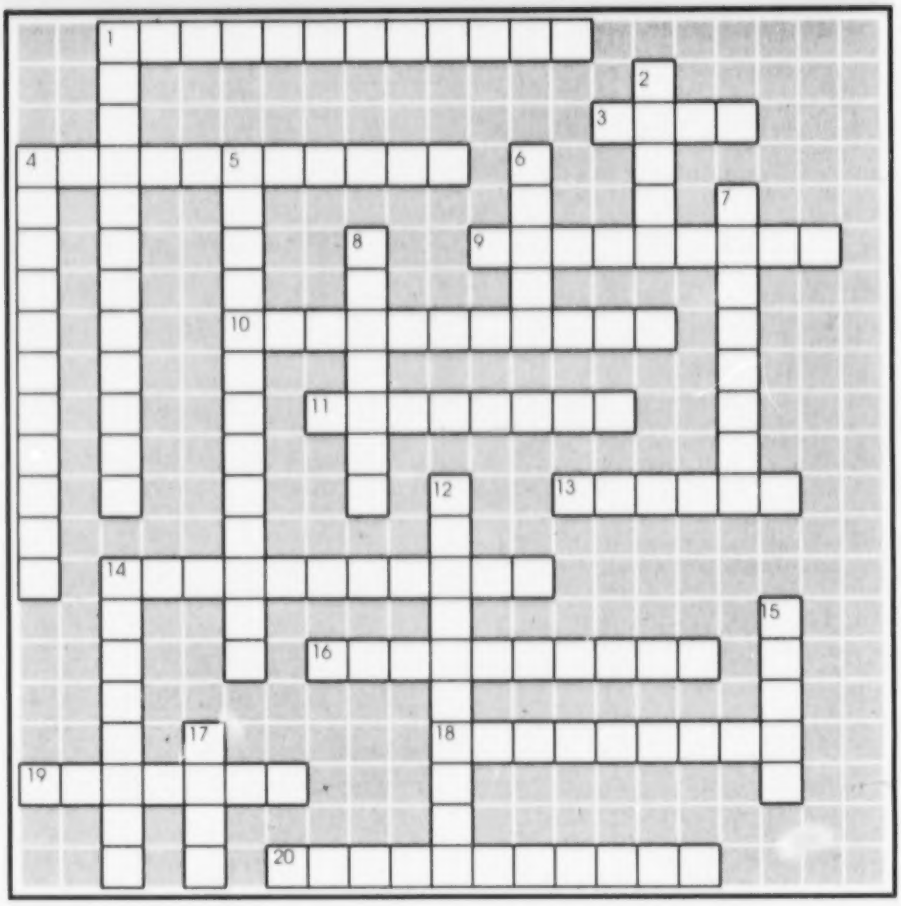
Instructions:

1. Distribute the crossword puzzle to each student.

2. Have the students complete the crossword puzzle, using their field notebooks if necessary.

3. Discuss any questions the students raise.

Geo-crossword Puzzle



ACROSS

1. Indicates changes of elevation on a topographic map. (2 words)

3. Hard, inorganic material formed from one or more minerals.

4. Situation when large chunks of rock fall due to uneven weathering. (2 words)

9. Rock that makes up most of the Big and Little Pinnacles.

10. Rock fold.

11. The Native American name for Pilot Mountain.

13. A kind of plant that causes chemical weathering.

14. Rock formed from layers of sediment.

16. Plant roots cause this type of weathering.

18. System of "recycling" rocks.

19. The movement of rock material by wind, water or ice.

20. Type of map that tells the elevations of the Sauratown Mountains—the mountains away from the mountains.

DOWN

1. Evidence of a shore or near shore environment.

2. Crack in a rock caused by softer minerals weathering faster.

4. Type of rock produced when other rocks are subjected to heat and pressure.

5. A series of folds in the Earth.

6. Large crack in the Earth caused by rocks moving against each other.

7. Big or Little _____

8. Rock formed from magma or lava.

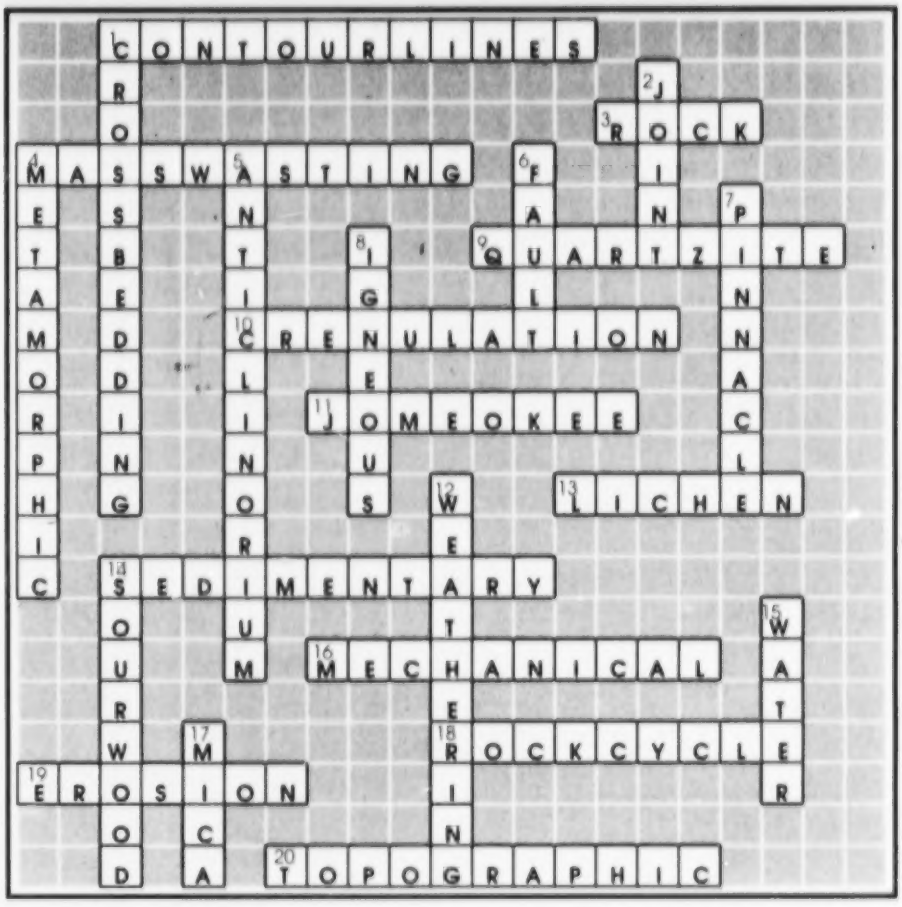
12. The breakdown of rocks by chemical or mechanical means.

14. Type of leaf.

15. Major agent of weathering and erosion.

17. Shiny mineral that is common at Pilot Mountain.

Geo-crossword Puzzle Answers



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VOCABULARY

Anticlinorium - Series of convex folds, wherein the regional rock terrain has been arched upwards as a result of applied external horizontal compression stresses. These stresses produced the folds and faults or rock displacements that now form this area–resulting in the Sauratown Mountains.

Chemical weathering - A process that changes the minerals in rocks, resulting in a weakening of the rocks.

Conglomerate - Rock composed of rounded, water worn pebbles usually of quartz, cemented by the mass of finer material filling the spaces in between.

Contour lines - The thin lines on a topographic map that indicate elevation.

Crenulation - Folds in rocks caused by pressure.

Crossbedding - The sweeping, arc-like beds that lie at an acute angle to the general horizontal stratification. Crossbedding reflects the direction of water current flow.

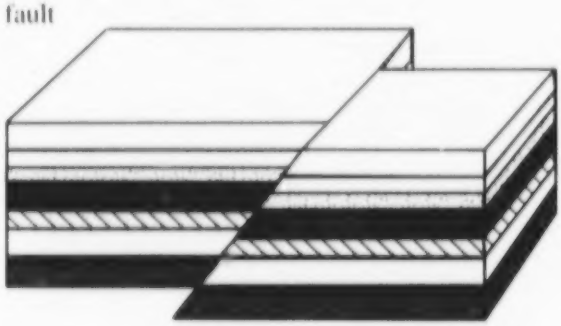
Crustal plates - Granitic plates on which the continents ride, also known as tectonic plates. When these plates collide they push up mountains and create metamorphic rock due to the pressure of their collision.

Erosion - The wearing down and carrying away of rocks and soil by wind, moving water or moving ice.

Fault - A break in the continuity of a rock formation caused by the shifting or dislodging of the Earth's crust. Shifting of crustal plates along faults cause earthquakes.

Faulting - In geology, a fracture of the Earth in which layers of rock slide up or down or sideways along the break.

fault



Geology - The study of the planet Earth • the materials from which it is made, the processes that act on these materials, the products formed, and the history of the planet and its life-forms since its origin.

Geologic process - The breaking down and building up of rocks, such as weathering, erosion, sedimentation and volcanic action, the phenomena of how the Earth is shaped.

Igneous rocks - Rocks that form when magma cools and hardens either underground (intrusive) or above ground (extrusive). Granite is a form of intrusive igneous rock.

Joint - Crack in a rock caused by softer minerals weathering away.

Lava - Molten rock that issued from a volcano or a fissure onto the Earth's surface.

Lichen - A unique plant that is made up of a fungus and an alga. It secretes a mild acid that causes chemical weathering.

Magma - The molten material from which igneous rocks are formed.

Mass wasting - Situation when large pieces of rock break off because underlying minerals have weathered unevenly.

Mechanical weathering - The breakdown of rocks by wind, water, ice, friction and gravity.

Metamorphic rocks - Rocks that are formed when heat and pressure change the mineral composition and grain size of igneous or sedimentary rocks. For example, heat and pressure on sandstone turns it into quartzite.

Mineral - An inorganic substance occurring naturally in the Earth and having a consistent and distinctive set of physical properties, and a composition that can be expressed by a chemical formula.

Mica - One of the common rock forming minerals, an important constituent of granite.

Monadnock - A hill of highly resistant rock left as a residue of erosion that stands above the surrounding area.

Peneplain - Vast plain of rolling hills not yet worn entirely smooth by erosion.

Quartz - A hard, crystalline mineral of silicon dioxide, SiO_2.

Quartzite - A rock formed by the metamorphism of sandstone. One of the hardest and most resistant of all rocks. This is the dominant rock of the Big and Little pinnacles at Pilot Mountain State Park.

Rock - A naturally occurring consistent mass of one or more minerals; the three rock types are named according to their formation processes: sedimentary, metamorphic and igneous.

Rock cycle - The process whereby one rock type changes into another.

Sedimentary rocks - Layered rocks. Loose sediments wash into rivers, etc., settle on the bottom and begin to pile up. Over time, pressure increases, compacting and cementing the layers.

Sediments - Particles of rock resulting from weathering, ranging in size from coarse gravel to fine powdery clay, carried away by erosion to eventually be deposited in streams, rivers, lakes and oceans.

Weathering - The breaking down of rock by the action of water, ice, plants and chemicals. Weathering wears down all rocks but at different rates. Examples of weathering are:

Freeze-crack cycle - When water seeps into the cracks and freezes, the expansion causing the rock to split (ice wedging);
Root destruction - Plants growing in crevices and cracks have roots which apply pressure to the rocks causing the cracks to widen. This can cause rocks to split;
Chemical breakdown - Some minerals react with the air and water, dissolving the materials holding rocks together;
Water - Fast flowing streams carrying soil, sand, pebbles, etc., carve away the rocks they flow over. Groundwater, rain or snow melt that has trickled deep into the ground through cracks and pores in rocks, can dissolve materials. (Example: Linville Caverns);
Wind - High speed winds carrying sand and dust shape rocks in dry regions.

Xenolith - Literally, a stranger rock, which was surrounded during the movement of magma to form an unrelated inclusion within the surrounding igneous rock.

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Medoc Mountain State Park Environmental Education Learning Experience *Rockin' on the Ridge.* For more information, contact Medoc Mountain State Park, Rt. 3, Box 219-G, Enfield, NC 27823.

Morrow Mountain State Park Environmental Education Learning Experience *Old as the Hills.* For more information, contact Morrow Mountain State Park, Rt. 5, Box 430, Albermarle, NC 28001.

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SCHEDULING WORKSHEET

For office use only:
Date request received_____ Request received by_____

1) Name of group (school) _____

2) Contact person _____ _____
name phone (work) (home)

_____
address

3) Day/date/time of requested program _____

4) Program desired and program length _____

5) Meeting place _____

6) Time of arrival at park _____ Time of departure from park _____

7) Number of students _____ Age range (grade) _____
(Note: A maximum of 30 participants is recommended.)

8) Number of chaperones _____
(Note: One adult for every 10 students is recommended.)

9) Areas of special emphasis _____

10) Special considerations of group (e.g. allergies, health concerns, physical limitations)_____
_____

11) Have you or your group participated in park programs before? If yes, please indicate previous programs attended: _____
_____

12) Are parental permission forms required? _____ If yes, please use the Parental Permission form on page 8.2.

I, _____, have read the entire Environmental Education Learning Experience and understand and agree to all the conditions within it.

Return to: Pilot Mountain State Park
Route 1, Box 21
Pinnacle, NC 27043

Fax: (910) 325-2751

PARENTAL PERMISSION FORM

Dear Parent:

Your child will soon be involved in an exciting learning adventure - an environmental education experience at **Pilot Mountain State Park**. Studies have shown that such "hands-on" learning programs improve children's attitudes and performance in a broad range of school subjects.

In order to make your child's visit to "nature's classroom" as safe as possible we ask that you provide the following information and sign at the bottom. Please note that insects, poison ivy and other potential risks are a natural part of any outdoor setting. We advise that children bring appropriate clothing (long pants, rain gear, sturdy shoes) for their planned activities.

Child's name _____

Does your child:

- Have an allergy to bee stings or insect bites?_____
  If so, please have them bring their medication and stress that they, or the group leader, be able to administer it.

- Have other allergies? _____

- Have any other health problems we should be aware of?_____
  _____

- In case of an emergency, I give permission for my child to be treated by the attending physician. I understand that I would be notified as soon as possible.

_____ _____
Parent's signature date

Parent's name _____ Home phone _____
(please print) Work phone _____

Family Physician's name _____ phone _____

Alternate Emergency Contact

Name_____ phone _____

NORTH CAROLINA PARKS & RECREATION
PROGRAM EVALUATION

Please take a few moments to evaluate the program(s) you received. This will help us improve our service to you in the future.

1. Program title(s) _____ Date _____
   Program leader(s) _____

2. What part of the program(s) did you find the most interesting and useful? _____
   _____

3. What part(s) did you find the least interesting and useful? _____
   _____

4. What can we do to improve the program(s)? _____
   _____
   _____

5. General comments _____
   _____
   _____
   _____

LEADERS OF SCHOOL GROUPS AND OTHER ORGANIZED YOUTH GROUPS
PLEASE ANSWER THESE ADDITIONAL QUESTIONS:

6. Group (school) name _____

7. Did the program(s) meet the stated objectives or curriculum needs? _____
   If not, why? _____
   _____

Please return the completed form to park staff. Thank you.

Pilot Mountain State Park
Route 1, Box 21
Pinnacle, NC 27043
Fax: (910) 325-2751